# Chapter Three: Contents

**(Activity Generation – 10 December 2002 – LA-UR 01-5712 – Portland Study Reports)**

# Chapter Three—Activity Generation

## 1. INTRODUCTION

This chapter documents the input parameters and conditions that were set to generate the initial activity set called AS-1. The general documentation for the Activity Generator may be obtained from the TRANSIMS web site http://transims.tsasa.lanl.gov. A summary of that document is given here.

The generated population of households and individuals is described in the previous chapter. One synthetic individual is created for each person in the true population. The Activity Generator assigns a set of activities to each synthetic individual in the population. This is done one synthetic household at a time. Based on household demographics, each household in the synthetic population is matched with a collection of households in an activity survey. One of these possible matching households is then selected according to a probability distribution, and the activities of that household are assigned to members of the synthetic household. The sequence of activities in this set is held as constant as possible including all of the intra-household shared rides. The times of the activities (within a range) and the modes to reach the activities also do not change from the survey. The activity locations are, of course, different.

For mode and location choice, the general philosophy for the Activity Generator differs from that of the econometric models under development elsewhere. Those models rely on multi-parameter statistical fits to the survey data. Calibration is accomplished by adding terms to the model until the ground counts and model estimates match to some degree of accuracy. Here the modeling is different. A simple location choice model is fit to the survey, and mode and final location choices are made by a series of feedback loops. (See the red loops in Figure 2, Volume One (*Introduction/Overview*), Chapter Four (*The Portland Study Flow of Runs*) and Volume Three (*Feedback Loops*), Chapter Five (*Mode Choice*) of the Portland Study reports.)

The simple location choice model is

$$P_l = (at)_l \exp(\beta_m (t_{s,l})^k)$$

where

$P_l$ is the probability of choosing location $l$

$(at)_l$ is the attractor at location $l$

$\beta_m$ is the mode coefficient for mode $m$

$(t_{s,l})^k$ is the travel time between locations $s$ and $l$

$k$ is a constant.

The attractor and the mode coefficient in the above equation are determined by a statistical fit to the household survey and the employment and land use data assigned to the activity locations of the network.

Freight and itinerant traveler trips were included in the simulation using trip tables supplied by Portland Metro.

# 2. SURVEY HOUSEHOLDS

Portland Metro conducted a two-day activity survey of 5863 households. The results of the first day of this survey for 3473 households were used in this study. An example of the raw data from the survey for household 200137 is show below. A complete codebook for the survey is given in Section 10 of this Chapter.

## 2.1.1 RAW SURVEY RECORDS

```
2,4,200137,1,1,1,16,"CHEZ ELLE BEAUTY
  SALON",2,900,1,1030,1,2,7,"",,,,,,,,,"","",,,,,"",,,1,1,1,2,2,,,4,,,850,
  1,900,1,0,10,2,"",,1

2,4,200137,1,1,2,20,"HOME",2,1040,1,1120,1,2,7,"",,,,,,,,,"","",,,,,,"",,,1
  ,1,1,3,2,,,4,,,1030,1,1040,1,0,10,2,"",,1

2,4,200137,1,1,3,14,"MONTGOMERY
  WARDS",2,1135,1,1235,2,2,7,"",,,,,,,,,"","",,,,,,"",,,1,1,1,1,2,,,4,,,112
  0,1,1130,1,0,10,2,"",,1

2,4,200137,1,1,4,51,"HOME",2,100,2,205,2,2,7,"",,,,,,,,,"","",,,,,,"",,,1,1
  ,1,3,2,,,4,,,1245,2,100,2,0,15,2,"",,1

2,4,200137,1,1,5,14,"KIENOWS",2,215,2,315,2,2,7,"",,,,,,,,,"","",,,,,,"",,,
  1,1,1,1,2,,,4,,,205,2,215,2,0,10,2,"",,1

2,4,200137,1,1,6,51,"HOME",2,325,2,455,2,2,7,"",,,,,,,,,"","",,,,,,"",,,1,1
  ,1,3,2,,,4,,,320,2,325,2,0,5,2,"",,1

2,4,200137,1,1,7,11,"PANCHOS",2,500,2,600,2,2,7,"",,,,,,,,,"","",,,,,,"",,,
  1,1,2,2,2,,,4,,,455,2,500,2,0,5,2,"",,1

2,4,200137,1,1,8,51,"HOME",1,605,2,100,1,2,,"",,,,,,,,,"","",,,,,,"",,,,,,
  ,,,,,,,,,,,,"",,1

2,4,200137,1,2,1,12,"GOOD SAMARITIAN
  HOSPITAL",2,215,2,1130,2,2,7,"",,,,,,,,,"","",,,,,,"",,,1,1,1,1,2,,,4,,,2
  00,2,215,2,0,15,2,"",,1

2,4,200137,1,2,2,51,"HOME",2,1145,2,200,1,2,7,"",,,,,,,,,"","",,,,,,"",,,1,
  1,1,3,2,,,4,,,1130,2,1145,2,0,15,2,"",,1

2,4,200137,2,1,1,51,"HOME",1,830,1,450,2,2,,"",,,,,,,,,"","",,,,,,"",,,,,,
  ,,,,,,,,,,,,"",,1

2,4,200137,2,1,2,11,"PANCHOS",2,500,2,600,2,2,7,"",,,,,,,,,"","",,,,,,"",,,
  1,2,2,2,2,,,4,,,455,2,500,2,0,5,2,"",,1

2,4,200137,2,2,1,51,"HOME",1,830,1,100,1,2,,"",,,,,,,,,"","",,,,,,"",,,,,,
  ,,,,,,,,,,,,"",,1
```

In TRANSIMS, the survey results are transformed to a simple file giving the person and household IDs, the activity types, the mode of travel, the start and end times of the activities, and the locations where the activity took place. An example of the entries in the file for household 200137 is given in Table 1.

**Table 1. The raw activity survey data is transformed to a file with a minimum of entries. This table shows the entries in the file for household 200137. `SAMPNO` is the household number. The person ID is given in the `PERSNO` field. The activities are numbered sequentially in `ACTNO`. Each activity type is given a number identifier and is in the column marked `ACTID`. A flag in the `AT_HOME` column denotes whether the activity took place at home. `WRTHERE` is a flag that denotes a change in activity locations. Mode and driver are given in their respective columns. `NUMVEH` is the number in the vehicle. The location of the activity is geo-coded and given in columns `GEOX` and `GEOY`.**

| SAMPNO | PERSNO | ACTNO | ACTID | AT_HOME | WRTHERE | MODE | DRIVER | NUMVEH | ACTSTART | ACTEND | GEOX | GEOY |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200137 | 1 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 540 | 7657414 | 686984.3 |
| 200137 | 1 | 1 | 3 | 2 | 2 | 2 | 1 | 1 | 540 | 630 | 7653721 | 688412.6 |
| 200137 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 640 | 680 | 7657414 | 686984.3 |
| 200137 | 1 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 695 | 755 | 7673690 | 681890.1 |
| 200137 | 1 | 4 | 0 | 1 | 2 | 2 | 1 | 1 | 780 | 845 | 7657414 | 686984.3 |
| 200137 | 1 | 5 | 2 | 2 | 2 | 2 | 1 | 1 | 855 | 915 | 7656295 | 688683.8 |
| 200137 | 1 | 6 | 0 | 1 | 2 | 2 | 1 | 1 | 925 | 1015 | 7657414 | 686984.3 |
| 200137 | 1 | 7 | 4 | 2 | 2 | 2 | 1 | 2 | 1020 | 1080 | 7656613 | 687307.8 |
| 200137 | 1 | 8 | 0 | 1 | 2 | 2 | 1 | 2 | 1085 | 1500 | 7657414 | 686984.3 |
| 200137 | 1 | 9 | 0 | 1 | 1 | 1 | 0 | 0 | 1500 | 1620 | 7657414 | 686984.3 |
| 200137 | 2 | 0 | 0 | 1 | 2 | 1 | 0 | 0 | 0 | 510 | 7657414 | 686984.3 |
| 200137 | 2 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 510 | 1010 | 7657414 | 686984.3 |
| 200137 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 1020 | 1080 | 7656613 | 687307.8 |
| 200137 | 2 | 3 | 0 | 1 | 2 | 2 | 2 | 2 | 1085 | 1620 | 7657414 | 686984.3 |

The complete TRANSIMS activity file contains 13 columns. These are:

1) `SAMPNO`: This column is the household ID from the survey.

2) `PERSNO`: The person ID from the survey is in this column.

3) `ACTNO`: The activities for each person are number sequentially and given here.

4) `ACTID`: The survey contains 28 activity types. With the concurrence of Portland Metro, these were collated into nine activity types for this study. The nine activity types are given in Table 2. School or college activity types in the table were determined by age of the participant

**Table 2. This table gives the TRANSIMS activity IDs used in the study.**

| TRANSIMS ID | TRANSIMS Description |
|---|---|
| 0 | Home |
| 1 | Work |
| 2 | Shop |
| 3 | Visit |
| 4 | Social/Recreational |
| 5 | Other |
| 6 | Serve Passenger |
| 7 | School |
| 8 | College |

The correspondence between the activity types of the survey and those used in the study is in Table 3.

**Table 3. This table gives the correspondence between the 28 activity types of the survey and the nine activity types used in the study.**

| Survey ID | Survey Descripion | TRANSIMS ID | TRANSIMS Description |
|---|---|---|---|
| 11 | Meals | 4 | Social/Recreational |
| 12 | Work | 1 | Work |
| 13 | Work-related | 1 | Work |
| 14 | Shopping (general) | 2 | Shop |
| 15 | Shopping (major) | 2 | Shop |
| 16 | Personal services | 3 | Visit |
| 17 | Medical care | 3 | Visit |
| 18 | Professional services | 3 | Visit |
| 19 | Household or personal business | 3 | Visit |
| 20 | Household maintenance | 2 | Shop |
| 21 | Household obligations | 3 | Visit |
| 22 | Pick-Up/Drop-Off passengers | 6 | Serve Passenger |
| 31 | Visiting | 4 | Social/Recreational |
| 32 | Casual entertaining | 4 | Social/Recreational |
| 33 | Formal entertaining | 4 | Social/Recreational |
| 41 | School | 7or 8 | School/College |
| 42 | Culture | 4 | Social/Recreational |
| 43 | Religion/Civil Services | 4 | Social/Recreational |
| 44 | Civic | 4 | Social/Recreational |
| 45 | Volunteer work | 4 | Social/Recreational |
| 51 | Amusements (at-home) | 0 | Home |
| 52 | Amusements (out-of-home) | 4 | Social/Recreational |
| 53 | Hobbies | 4 | Social/Recreational |
| 54 | Exercise/Athletics | 4 | Social/Recreational |
| 55 | Rest and relaxation | 4 | Social/Recreational |
| 56 | Spectator athletic events | 4 | Social/Recreational |
| 90 | Incidental trip | 5 | Other |
| 91 | Tag along trip | 5 | Other |

The anchor activities (see the general documentation for the Activity Generator) were home, work, and school or college. The Route Planner time priorities (see the general documentation for the Route Planner) for each activity type are given in the configuration file in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*), Chapter Three (*AS-1*).

5) `AT_HOME`: This is a flag to show whether the activity took place at home. A "1" in the column indicates that it was a home activity.

6) `WRTHERE`: This column is used by the Activity Generator to determine if a trip was made between the activity and the preceding one. A "1" in the column indicates no change in activity locations.

7) `MODE`: The modes' IDs from the raw survey were transformed to nine modes used in this study. In TRANSIMS, each mode is given a symbol for use in the Route Planner. The mode numbers, symbols, and their meanings are in Table 4.

**Table 4. The mode numbers, symbols, or mode strings, and a description of the modes used in the Study are given here. Each mode string starts and ends with the symbol "w", which indicates a walk.**

| Number | Symbol | Meaning |
|---|---|---|
| 1 | w | walk |
| 2 | wcw | walk-car-walk |
| 3 | wtw | walk-transit-walk |
| 4 | wlw | walk-light rail-walk |
| 5 | wcwtw | park&ride in |
| 6 | wtwcw | park&ride out |
| 7 | wiw | bike |
| 8 | wkw | inter-household shared ride |
| 9 | wKw | school bus |

Each TRANSIMS activity takes place at an activity location. Parking locations, where vehicles start and end their journeys, are different from activity location. To access a vehicle, a traveler must walk between the activity location and the parking location.

8) `DRIVER`: This is an indicator variable to establish the driver for an automobile trip. A "1" in this column indicates the driver of the vehicle.

9) `NUMVEH`: This variable is the number of travelers in the vehicle on the trip.

10) `ACTSTART`: This is the start time of the activity in minutes since midnight.

11) `ACTEND`: This is the end time of the activity in minutes since midnight.

12) `GEOX` and `GEOY`: These two columns are the geocoded locations of the survey activities.

Many of the reported survey activities and times were edited to make them consistent with TRANSIMS. In particular, the times activities took place were changed when there were obvious mismatches in the times for shared rides.

Table 5 demonstrates one such survey result. The activities are for the two persons in survey household 200137. The table shows the household ID (`hhid`), the activity types (`i1` and `i2`), the at-home flags (`h1` and `h2`), the were-there flags (`w1` and `w2`), the modes (`m1` and `m2`), the driver flags (`d1` and `d2`), and the number of persons on the trip (`p1` and `p2`). The last three time periods are the ones of interest. At 1020, the two persons arrive together at an activity in a car with the first person as the driver. They then return home with the first person in the household the driver. The highlighted lines in the table show the return to home. In the survey, the first person reported the return to home at 1085, while the second person reported the return to be at 1080. For TRANSIMS, these two times were made to match.

**Table 5. The survey data for household 200137 has an obvious mismatch in the shared ride times for the last activity for both travelers in the household. The activity after the last shared ride is scheduled to begin at 1085 for the first person in the household and at 1080 for the second person.**

| hhid | time | i1 | h1 | w1 | m1 | d1 | p1 | i2 | h2 | w2 | m2 | d2 | p2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 200137 | 0 | 0 | 1 | 1 | -1 | -1 | -1 | 0 | 1 | 1 | -1 | -1 | -1 |
| 200137 | 540 | 5 | 2 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 640 | 5 | 1 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 695 | 2 | 2 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 780 | 0 | 1 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 855 | 2 | 2 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 925 | 0 | 1 | 2 | 2 | 1 | 1 | x | x | x | x | x | x |
| 200137 | 1020 | 5 | 2 | 2 | 2 | 1 | 2 | 5 | 2 | 2 | 2 | 2 | 2 |
| **200137** | **1080** | **x** | **x** | **x** | **x** | **x** | **x** | **0** | **1** | **2** | **2** | **2** | **2** |
| **200137** | **1085** | **0** | **1** | **2** | **2** | **1** | **2** | **x** | **x** | **x** | **x** | **x** | **x** |

# 3. BINARY TREE

In TRANSIMS, each household in the synthetic population is assigned the activity sequence from one of the survey households. These are assigned by matching some of the household demographics in the survey and the synthetic population. Since there are not enough survey households to do an exhaustive cross-classification of potentially useful demographics for this match, a classification tree is used for the matching. The procedures for generating such a tree are given in the general documentation on the Activity Generator.

The classification tree used in this study is given in Table 6. The classification tree itself is partially in table form. The most important variables make up the "row" and "column" of the table. These are the number of workers (`WORKERS`) and the household size (`HHSIZE`). Other variables in the tree are: age of the householder (`HHAGE`), the household income grouped in categories (`INCOME`), the number of persons in the household less than 5 years of age (`ALT5`) and between 5 and 15 years of age(`A5-15`), and the household density in households/acre at the home location (`HHDensity`).

The number of survey households at each node in the tree is given in parentheses. These are further classified as those survey households with no non-driving children or with children less than 16 years of age. It is interesting to note the disproportionate number of older single- or two-person households with no workers in the survey. These represent retired persons who have time to fill out the surveys. This points out a general need to unbias the survey results for the census. By taking into account the demographics of both the synthetic population and the survey population, the activity generation in TRANSIMS does this automatically.

**Table 6. The classification tree for assignment of survey households is partially in table form. The two most important classification demographics are the number of workers in the household and the household size (`HHSIZE`). The number of survey households in each category are given in parentheses.**

| WORKERS=0 | WORKERS=1 | WORKERS=2 | WORKERS>2 |
|---|---|---|---|
| HHSIZE=1<br>HHAGE<38.5 (34)(34,0)<br>HHAGE>38.5 (319)(319,0) | HHSIZE=1 (705)(705,0) | HHSIZE=2 (677)(677,0) | HHSIZE=3 (75)(75,0) |
| HHSIZE=2<br>HHAGE<53.5<br>INCOME<5.5 (25)(12,13)<br>INCOME>5.5 (15)(12,3)<br>HHAGE>53.5 (268)(267,1) | HHSIZE=2<br>A5-15=0 (304)(291,13)<br>A5-15>0 (48)(0,48) | HHSIZE=3 (248)(78,170) | HHSIZE=4<br>HHAGE<46.5 (28)(17,11)<br>HHAGE>46.5 (24)(18,6) |
| HHSIZE>2 (32)(8,24) | HHSIZE=3<br>A5-15<=1<br>HHAGE<29.5 (18)(1,17)<br>HHAGE>29.5 (89)(36,53)<br>A5-15>1 (24)(0,24) | HHSIZE=4<br>ALT5=0<br>A26-45=0 (21)(8,13)<br>A26-45>0 (134)(7,127)<br>ALT5>0 (69)(0,69) | HHSIZE>4 (43) (10,33) |
| **KEY**<br>(32)(8,24)<br>32 households<br>8 with no nondriving children<br>24 with nondriving children | HHSIZE=4<br>A5-15<=1 (73)(4,69)<br>A5-15>1 (49)(0,47) | HHSIZE>4<br>A5-15<=2 (49)(1,48)<br>A5-15>2<br>HHDensity<1.29 (18)(0,18)<br>HHDensity>1.29 (19)(0,19) | |
| | HHSIZE>4<br>A5-15<=2 (40)(1,39)<br>A5-15>2 (27)(0,27) | | |

# 4. WEIGHTING THE SYNTHETIC HOUSEHOLDS

In TRANSIMS, an activity pattern for a synthetic household is determined by overlaying an activity pattern from a similar household from the household survey. Each synthetic household in the TRANSIMS population is assigned one of the activity patterns of the survey households at a node in the tree. The survey household is chosen randomly in proportion to the weight assigned to the survey household.

In this methodology, each survey household is assigned a weight. The weights assigned to the survey households at a node in the tree are proportional to the probability of selecting that household's activity sequence. Each survey household at a node of the tree has an equal chance of being selected if the weights of all households at the node are unity.

The first step in generating an activity set for the synthetic population is to let all of the survey households have unit weights. Because of underreporting of trips in the survey households or sampling households with less active lifestyles, the total number of trips generated for the synthetic population using this procedure is usually too low. To remedy this, the survey households with more trips are weighted higher than those with less trips. The weighting scheme used in the Portland Study is described below.

Suppose that with unit weights, there are p% too few trips. (In the Portland Study, p=25% for combined drive and transit trips). Let $X = (1 + p/100)$. At a node in the tree, let the number of drive and transit trips for the *m* survey households at the node be

$$n_1, n_2 \ldots n_m$$

If each survey household at the node has a unit weight for selection to overlay its activity pattern on a synthetic household, then the average number of drive plus transit trips generated for the synthetic households at this node is

$$\bar{n} = \sum n_i / m$$

The goal is to find a set of weights, $w_1, w_2, \ldots, w_m$ so that the weighted average of the number of trips generated at a node is $X$ times the original average. That is

$$\sum w_i n_i / \sum w_i = X\bar{n}$$

Since $X > 1$, this equation may be satisfied by giving the survey households with more than the average number of trips more weight. Here we use

$$w_i = (1 + \beta n_i^k)$$

as the general form of the weighting function, where $\beta$ and $k$ are calibration constants.

The form of this function for various values of *k* is shown in *Fig. 1*. The lines in this figure represent the relative weights from *k=0* to *k=6*, based on the number of trips in the

household. Those lines with the smallest slopes give more similar weighting to all of the households at the node of the tree. It may not be desirable to assign one household significantly more weight than all of the others. In these cases, the activity pattern of the one household would be overutilized at the expense of the others. Given the steep slopes of these lines for the larger values of *k*, it is probably best to use the smallest *k* that satisfies the equation above.

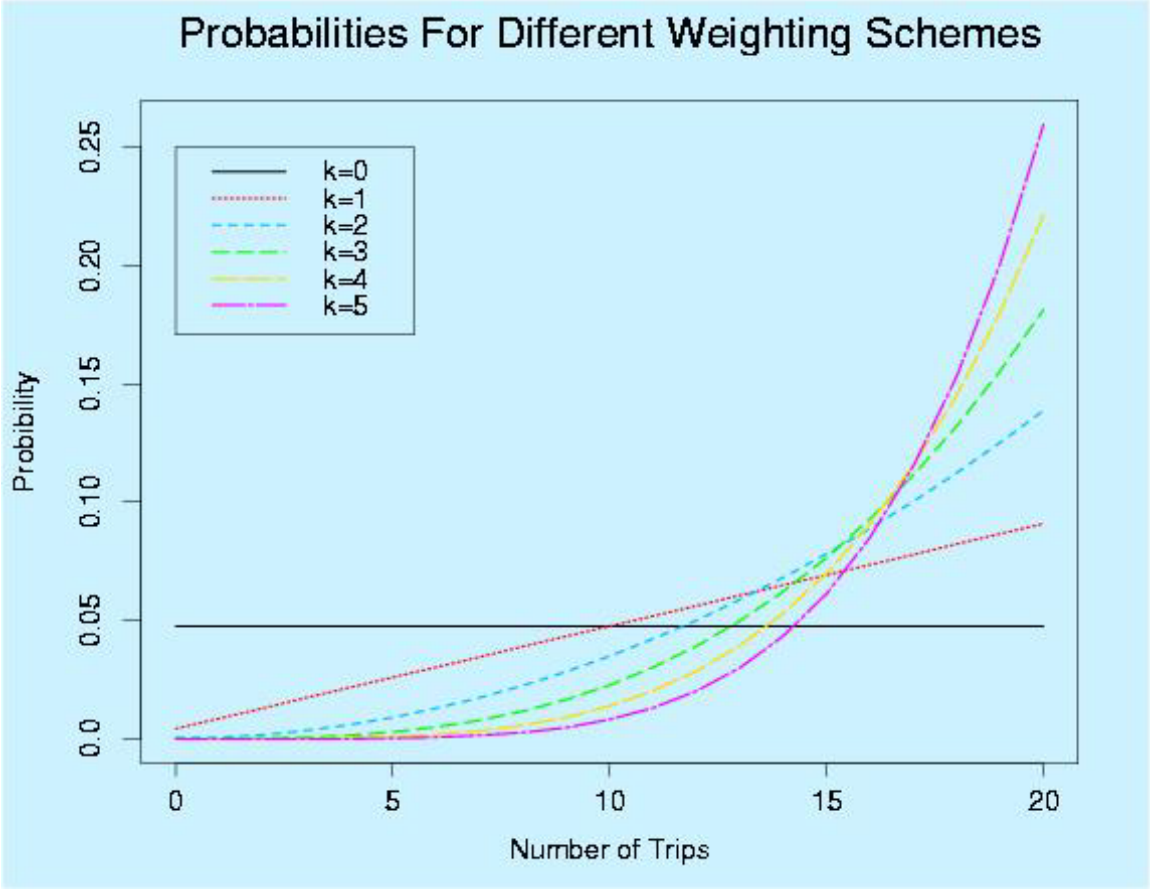


*Fig. 1. The probability of selecting households given the number of transit and auto trips as the weighting value,* k*, changes.*

In the Study, the smallest integer value of $k$ was determined for each node so that the weights remained positive. $\beta$ is obtained by solving

$$\sum(1+\beta n_i^k)n_i / \sum(1+\beta n_i^k) = X\bar{n}$$

The solution for $\beta$ in this equation is

$$\beta = (X-1)m\bar{n} / [\sum n_i^{k+1} - X\bar{n}\sum n_i^k]$$

For a particular value of *k*, the solution for $\beta$ in the above equation may be less than 1. For these cases, a larger value of *k* must be selected. Solutions of the equation with negative values of $\beta$ lead to negative weights for some of the households.

The solutions for *k* for each node in the classification tree are given in Table 7. These are the minimum integer values of *k* that assign positive weights to each household in the node. Using these values of *k* and the fit value of $\beta$, each household was assigned the weight

$$w_i = (1 + \beta n_i^k)$$

**Table 7. The values of *k* for each of the 45 nodes in the classification tree. In some cases, where there is a small number of households at the node, no solution for *k* exists, so the value of 0 was used.**

| DEMO-1 | DEMO-2 | DEMO-3 | DEMO-4 | CHILDREN | #SURVEY | K |
|---|---|---|---|---|---|---|
| Workers=0 | HHSIZE=1 | HHAGE<38.5 | | No | 34 | 1 |
| Workers=0 | HHSIZE=1 | HHAGE>38.5 | | No | 319 | 1 |
| Workers=0 | HHSIZE=2 | HHAGE>53.5 | | No | 267 | 2 |
| Workers=0 | HHSIZE=2 | HHAGE<53.5 | INCOME<5.5 | No | 12 | 1 |
| Workers=0 | HHSIZE=2 | HHAGE<53.5 | INCOME>5.5 | No | 12 | 1 |
| Workers=0 | HHSIZE=2 | HHAGE>53.5 | | Yes | 1 | 0 |
| Workers=0 | HHSIZE=2 | HHAGE<53.5 | INCOME<5.5 | Yes | 13 | 1 |
| Workers=0 | HHSIZE=2 | HHAGE<53.5 | INCOME>5.5 | Yes | 3 | 0 |
| Workers=0 | HHSIZE>2 | | | No | 8 | 2 |
| Workers=0 | HHSIZE>2 | | | Yes | 24 | 1 |
| Workers=1 | HHSIZE=1 | | | No | 705 | 1 |
| Workers=1 | HHSIZE=2 | A5-15=0 | | No | 291 | 1 |
| Workers=1 | HHSIZE=2 | A5-15=0 | | Yes | 13 | 2 |
| Workers=1 | HHSIZE=2 | A5-15>0 | | Yes | 48 | 1 |
| Workers=1 | HHSIZE=3 | A5-15<=1 | HHAGE<29.5 | No | 1 | 0 |
| Workers=1 | HHSIZE=3 | A5-15<=1 | HHAGE>29.5 | No | 36 | 1 |
| Workers=1 | HHSIZE=3 | A5-15>1 | | yes | 24 | 2 |
| Workers=1 | HHSIZE=3 | A5-15<=1 | HHAGE<29.5 | Yes | 17 | 1 |
| Workers=1 | HHSIZE=3 | A5-15<=1 | HHAGE>29.5 | Yes | 53 | 1 |
| Workers=1 | HHSIZE=4 | A5-15<=1 | | No | 4 | 1 |
| Workers=1 | HHSIZE=4 | A5-15<=1 | | Yes | 69 | 1 |
| Workers=1 | HHSIZE=4 | A5-15>1 | | Yes | 47 | 1 |
| Workers=1 | HHSIZE>4 | A5-15<=2 | | No | 1 | 0 |
| Workers=1 | HHSIZE>4 | A5-15<=2 | | Yes | 39 | 2 |
| Workers=1 | HHSIZE>4 | A5-15>2 | | Yes | 27 | 2 |
| Workers=2 | HHSIZE=2 | | | No | 677 | 2 |
| Workers=2 | HHSIZE=3 | | | No | 78 | 2 |
| Workers=2 | HHSIZE=3 | | | Yes | 170 | 2 |
| Workers=2 | HHSIZE=4 | ALT5=0 | A26-45=0 | No | 8 | 2 |
| Workers=2 | HHSIZE=4 | ALT5=0 | A26-45>0 | No | 7 | 1 |
| Workers=2 | HHSIZE=4 | ALT5>0 | | Yes | 69 | 1 |
| Workers=2 | HHSIZE=4 | ALT5=0 | A26-45=0 | Yes | 13 | 2 |
| Workers=2 | HHSIZE=4 | ALT5=0 | A26-45>0 | Yes | 127 | 2 |
| Workers=2 | HHSIZE>4 | A5-15<=2 | | No | 1 | 0 |
| Workers=2 | HHSIZE>4 | A5-15<=2 | | Yes | 48 | 2 |
| Workers=2 | HHSIZE>4 | A5-15>2 | HHdensity<1.29 | Yes | 18 | 1 |
| Workers=2 | HHSIZE>4 | A5-15>2 | HHdensity<1.29 | Yes | 19 | 2 |
| Workers>2 | HHSIZE=3 | | | No | 75 | 2 |
| Workers>2 | HHSIZE=4 | HHAGE<46.5 | | No | 17 | 2 |
| Workers>2 | HHSIZE=4 | HHAGE>46.5 | | No | 18 | 3 |
| Workers>2 | HHSIZE=4 | HHAGE<46.5 | | Yes | 11 | 4 |
| Workers>2 | HHSIZE=4 | HHAGE>46.5 | | Yes | 6 | 3 |
| Workers>2 | HHSIZE>4 | | | No | 10 | 4 |
| Workers>2 | HHSIZE>4 | | | Yes | 33 | 3 |

# 5. ACTIVITY LOCATION ATTRACTORS/LAND USE

Activity attractors were computed for each of the eight activity types (`home` is excluded) in Table 8 and placed at each activity location. The attractors are a function of "land-use" characteristics at each of the activity locations in the network. The "land-use" data includes total employment, the number of households, total college enrollment, service employment, retail employment, other employment, government employment, and park area in acres. These data were combined using the functional form:

$$\prod_i a_i^{k_i^{(j)}}$$

where $a_i$ is "land-use" data *i*, and $k_i^{(j)}$ is an estimated coefficient for travel mode j.

**Table 8. Land-use data that include employment numbers by employment types are combined by the formula $\prod_i a_i^{k_i^{(j)}}$ to make attractors for each activity type in the Study.**

| Activity Type | Land-Use 1 | Land-Use 2 | Land-Use 3 | Land-Use 4 | Land-Use 5 |
|---|---|---|---|---|---|
| Work | Total employment | | | | |
| Shop | Number Households | Service Employment | Retail Employment | Other Employment | |
| Visit | Number Households | Service Employment | Retail Employment | Other Employment | |
| Social/Recreational | Number Households | Retail Employment | Park Area (in acres) | | |
| Other | Number Households | Service Employment | Retail Employment | Other Employment | Government Employment |
| Serve Passenger | Number Households | Total employment | | | |
| School | NA | | | | |
| College | Total Enrollment | | | | |

In the generation of AS-1, activity locations were assigned the attractor values directly from the application of the estimated formula:

$$\prod_i a_i^{k_i^{(j)}}$$

The value of zero was assigned to the activity location if all of the "Land-Use" variables in Table 8 had the value of zero at the location. In some of the feedback studies, these zero attractors were given a small value greater than zero. This allowed activity locations to be moved to any location.

# 6. MODE COEFFICIENTS

Location choice in the Study and in TRANSIMS in general is made using a simple logistic model. The form of the function is

$$p_j(i, \beta_m, A_j, K_j, t_{i,j}) \propto \prod_l a_l^{k_l^{(j)}} \exp(\beta_m t_{i,j}^{1/2})$$

where

- the origin is location *i*,
- the potential destination is *j*,
- $\beta_m$ is a coefficient that is estimated for each mode *m*,
- $A_j$ is the set of land-use variables $a_l$,
- $K_j$ is a set of estimated coefficients $k_l^{(j)}$, and
- $t_{i,j}$ is the travel time from location i to location *j*.

The coefficients $\beta_m$ and $k_l^{(j)}$ were estimated by maximum likelihood using the survey data as a base. Travel times were taken as scaled distances, and the locations were the 1260 travel analysis zones used by Portland Metro. The statistical fit was better using the square root of the travel time rather than the travel time itself, so the square root was used in the Study.

The coefficients, $\beta_m$, for each activity type and mode are shown in Table 9. Some of the coefficients in the table were not estimated because of a lack of data or the manner in which TRANSIMS treats some of the activities and modes, for example schools. Mode coefficients for park and ride (modes 5 and 6) were estimated as a combination of auto and transit (modes 2 and 3). In all cases, data for modes transit (3) and Max (4) were combined and a single estimate was used for both. Coefficients for activity type home (0) were taken to be the same as the work estimates.

**Table 9. The coefficients, $\beta_m$, for each activity type and mode.**

| Coefficient | Activity Type | Mode | Coefficient | Activity Type | Mode |
|---|---|---|---|---|---|
| -0.129 | 0 | 1 | -0.110 | 4 | 6 |
| -0.057 | 0 | 2 | -0.134 | 4 | 7 |
| -0.098 | 0 | 3 | -0.125 | 4 | 8 |
| -0.098 | 0 | 4 | -0.125 | 4 | 9 |
| -0.080 | 0 | 5 | -0.493 | 5 | 1 |
| -0.080 | 0 | 6 | -0.384 | 5 | 2 |
| -0.098 | 0 | 7 | -0.450 | 5 | 3 |
| -0.057 | 0 | 8 | -0.450 | 5 | 4 |
| -0.057 | 0 | 9 | -0.450 | 5 | 5 |
| -0.129 | 1 | 1 | -0.450 | 5 | 6 |
| -0.057 | 1 | 2 | -0.490 | 5 | 7 |
| -0.098 | 1 | 3 | -0.384 | 5 | 8 |
| -0.098 | 1 | 4 | -0.384 | 5 | 9 |
| -0.080 | 1 | 5 | -0.517 | 6 | 1 |
| -0.080 | 1 | 6 | -0.163 | 6 | 2 |
| -0.098 | 1 | 7 | -0.300 | 6 | 3 |
| -0.057 | 1 | 8 | -0.300 | 6 | 4 |
| -0.057 | 1 | 9 | -0.300 | 6 | 5 |
| -0.166 | 2 | 1 | -0.300 | 6 | 6 |
| -0.159 | 2 | 2 | -0.500 | 6 | 7 |
| -0.121 | 2 | 3 | -0.163 | 6 | 8 |
| -0.121 | 2 | 4 | -0.163 | 6 | 9 |
| -0.140 | 2 | 5 | -0.517 | 7 | 1 |
| -0.140 | 2 | 6 | -0.160 | 7 | 2 |
| -0.100 | 2 | 7 | -0.300 | 7 | 3 |
| -0.121 | 2 | 8 | -0.300 | 7 | 4 |
| -0.121 | 2 | 9 | -0.300 | 7 | 5 |
| -0.087 | 3 | 1 | -0.300 | 7 | 6 |
| -0.138 | 3 | 2 | -0.500 | 7 | 7 |
| -0.117 | 3 | 3 | -0.160 | 7 | 8 |
| -0.177 | 3 | 4 | -0.160 | 7 | 9 |
| -0.120 | 3 | 5 | -0.129 | 8 | 1 |
| -0.120 | 3 | 6 | -0.057 | 8 | 2 |
| -1.610 | 3 | 7 | -0.098 | 8 | 3 |
| -0.138 | 3 | 8 | -0.098 | 8 | 4 |
| -0.138 | 3 | 9 | -0.080 | 8 | 5 |
| -0.142 | 4 | 1 | -0.080 | 8 | 6 |
| -0.125 | 4 | 2 | -0.098 | 8 | 7 |
| -0.092 | 4 | 3 | -0.057 | 8 | 8 |
| -0.092 | 4 | 4 | -0.057 | 8 | 9 |
| -0.110 | 4 | 5 | | | |

# 7. Itinerant Travelers, Freight, and Travel Times

Portland Metro supplied numerous existing data sets to facilitate this demonstration of TRANSIMS technology. Itinerant travelers and freight, but not local deliveries, were generated using trip tables for the 1260 travel analysis zones and the Trip Table Activity Generator (see the general documentation on the Activity Generator for information on this procedure). A time of day is associated with each trip table. Additional data from Portland Metro included zone-to-zone travel times by time of day for drives, transit, and park and ride.

Zone-to-zone trip tables representing freight trips were given for four times of day, all day, 14:00-15:00, 16:30-17:30, and 15:30 to 17:30. These were converted to one trip table and the times for the trip were in proportion to the trips in each of these tables. The Trip Table Generator then produced one trip for each of the trips in the table. The endpoints of the trips were determined by the values of the attractors, `T_Org` and `T_Des`, on the network activity locations.

Auto trips representing itinerant travelers were generated by the Trip Table Activity Generator from two trip tables supplied by Portland Metro. The four tables represent four times of day: (7:00-9:00), (9:00-16:00), (16:00-18:00), and (0:00-7:00, 18:00-24:00). The time file developed for the Trip Table Generator for these trips reflects these times.

Portland Metro supplied zone-to-zone travel times by mode and time of day in five tables. These tables are for a.m. two-hour auto, a.m. two-hour total transit, a.m. two-hour park and ride times, mid-day one-hour auto travel times, and one-hour mid-day total transit travel times. These tables were used to construct travel times for each mode for 24 hours. The method was:

1) Walk
   The auto mid-day travel times multiplied by 40 mph were used for all walk times.

2) Drive (Auto)
   The following combinations of travel times were used:
   a) 0 to 6:30 a.m.: mid-day travel times multiplied by .9 were used.
   b) 6:30 a.m. to 9:00 a.m.: the a.m. two-hour travel times were used.
   c) 9:00 a.m. to 4:30 p.m.: mid-day travel times were used.
   d) 4:30 p.m. to 6:30 p.m.: the a.m. two-hour travel times were used with the origin and destination zones reversed.
   e) 6:30 to midnight: mid-day travel times multiplied by .9 were used.

3) Transit
   The transit trip tables were treated the same as the auto trip tables.

4) Light Rail
   Transit tables were used. This choice has implications in the mode selection feedback loop. In essence, since the Route Planner will find the best transit path between bus and light rail, this mode is probably not necessary.

5) Park and Ride
   The one park and ride travel time table was used for the entire 24 hours.

6) Bike
   The walk travel times were divided by 10 and were used as bike travel times.

7) Inter-household shared ride
   Auto travel times were used for this mode.

8) School bus
   Auto travel times were used for this mode.

The Activity Generator has the ability to use the travel time files directly, and this is recommended if there are many tens or hundreds of thousands of zones. Here, however, the number of zones is 1260, and the travel time tables fit into the memory of the machine. A special travel time function was coded into the Activity Generator and Activity Regenerator to read and store these tables. Use of the special travel time function improved the execution speed of the Activity Generator dramatically and provided a mechanism to manipulate travel times for special conditions during feedback loops.

# 8. Run Parameters (Configuration File Keys)

The configuration file keys used to generate activity set AS-1 are given in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*), Chapter Three (*AS-1*). AS-1 is the building block for all of the activity sets that follow. Particular attention was paid to the number of drive and transit trips. These were calibrated to the number that Portland Metro thought necessary by weighting the selection of the survey households. Configuration files used to generate trips for freight and itinerant travelers are also included in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Functions*), Chapter Three (*AS-1*).

# Appendix: Portland Metro Survey Code Book

The following is the Portland Metro activity survey code book. The raw survey activities listed in Section 2 follow this format.

| Name | Position |
|---|---|
| PHASE Phase<br>Format: F1 | 1 |

| Value | Label |
|---|---|
| 1 | Spring |
| 2 | Fall |
| 3 | Winter |

| | |
|---|---|
| STRATUM Stratum<br>Format: F2 | 2 |

| Value | Label |
|---|---|
| 1 | Multnomah Co-Urban,good PEF,LUM & Transit |
| 2 | Multnomah Co-Urban,bad PEF & Transit |
| 3 | Multnomah Co-Urban, good PEF & Transit |
| 4 | Multnomah Co-Light Rail Corridor |
| 5 | Rest of Multnomah Co |
| 6 | Clackamas County |
| 7 | Washington County |
| 8 | Columbia County (partial) |
| 9 | Yamhill County (partial) |
| 10 | Sample Enrichment (park-n-ride users) |

| | |
|---|---|
| SAMPNO Sample number<br>Format: F6 | 3 |
| PERSNO Person number<br>Format: F2 | 4 |
| DAYNO Day number<br>Format: F1 | 5 |
| ACTNO Activity number<br>Format: F2 | 6 |
| Q1 Q1 - What was your (first/next) activity?<br>Format: F2 | 7 |

| Value | Label |
|---|---|
| 11 | Meals |
| 12 | Work |
| 13 | Work-related |
| 14 | Shopping (general) |
| 15 | Shopping (major) |

16 Personal services
17 Medical care
18 Professional services
19 Household or personal business
20 Household maintenance
21 Household obligations
22 Pick-Up/Drop-Off passengers
31 Visiting
32 Casual entertaining
33 Formal entertaining
41 School
42 Culture
43 Religion/Civil Services
44 Civic
45 Volunteer work
51 Amusements (at-home)
52 Amusements (out-of-home)
53 Hobbies
54 Exercise/Athletics
55 Rest and relaxation
56 Spectator athletic events
90 Incidental trip
91 Tag along trip

Q2NAME Q2 - [LOCATION NAME] Where did the activity take place? 8
Format: A30

Q3 Q3 - Were you already there? 12
Format: F1

Value Label

1 Yes
2 No

Q4 Q4 - When did you start that activity? 13
Format: F4

Q4AMPM Q4 AM or PM 14
Format: F1

Value Label

1 am
2 pm

Q5 Q5 - When did you end that activity? 15
Format: F4

Q5AMPM Q5 AM or PM 16
Format: F1

Value Label

1 am
2 pm

Q6 Q6 - Did you make any trips during those [RESPONSE TO Q5]? 17

Format: F1

Value Label

1 Yes
2 No

Q7 Q7 - How did you get to the activity? 18
Format: F1

Value Label

1 Other
2 Walk
3 Bicycle
4 School Bus
5 Public Bus
6 MAX
7 Personal Vehicle
8 Non-personal Vehicle

Q7A Q7a - Other mode 19
Format: A20

Q8 Q8 - Did you have a vehicle available? 22
Format: F1

Value Label

1 Yes
2 No

Q8A Q8A - Would you have had to pay if you went by car? 23
Format: F1

Value Label

1 yes
2 no

Q8B Q8B - How much would you have had to pay? 24
Format: F5.2

Q8BTIME Q8TIME 25
Format: F1

Value Label

1 Hourly
2 Daily
3 Weekly
4 Monthly
5 Semesterly
6 Other

Q9 Q9 - How many people were in your party? 26
Format: F2

Q10 Q10 - Did you have a vehicle available? 27
Format: F1

Value Label

1 Yes
2 No

Q11 Q11 - Would you have had to pay to park if you went by car? 28
Format: F1

Value Label

1 Yes
2 No

Q11A Q11A - How much would you have had to pay? 29
Format: F5.2

Q11ATIME Q11TIME 30
Format: F1

Value Label

1 Hourly
2 Daily
3 Weekly
4 Monthly
5 Semesterly
6 Other

Q12 Q12 - What was the first route taken? 31
Format: A20

Q13NAME Q13 - Where did you board? 34
Format: A30

Q14 Q14 - How did you get to the stop? 38
Format: F1

Value Label

1 Drove and parked
2 Dropped off
3 Walked
4 Carpooled
5 Other

Q14A Q14a - How did you get from the stop to your destination? 39
Format: F1

Value Label

1 Drove & parked
2 Picked up
3 Walked
4 Carpooled
5 Other

6 Not asked - spring

Q15 Q15 - How did you pay for the trip? 40
Format: F1

Value Label

1 Cash
2 Ticket
3 Pass
4 Fareless square
5 Transfer

Q16 Q16 - Who subsidized your fare? 41
Format: F1

Value Label

1 Employer
2 Business/store
3 Other
4 None

Q17 Q17 - Did you transfer to another bus? 42
Format: F1

Value Label

1 Yes
2 No

Q18 Q18 - To what line did you transfer? 43
Format: A30

Q19 Q19 - Did you transfer again? 47
Format: F1

Value Label

1 Yes
2 No

Q19A Q19a - How many people were in your party? 48
Format: F2

Q20 Q20 - Which vehicle did you use? 49
Format: F2

Q21 Q21 - Were you the driver or passenger? 50
Format: F1

Value Label

1 Driver
2 Passenger

Q22 Q22 - Number in vehicle 51
Format: F2

Q23 Q23 - Where did you park? 52
Format: F1

Value Label

1 Parking lot/parking garage
2 Street
3 Driveway
4 Drive-through/Drop-off
5 Other
6 Did not park

Q24 Q24 - Did you pay for parking? 53
Format: F1

Value Label

1 Yes
2 No

Q25 Q25 - How much did you pay for parking? 54
Format: F5.2

Q25TIME Q25TIME 55
Format: F1

Value Label

1 Hourly
2 Daily
3 Weekly
4 Monthly
5 Semesterly
6 Other

Q26 Q26 - Who subsidized your parking? 56
Format: F1

Value Label

1 Employer
2 Business/store
3 Other
4 None

Q27 Q27 - What was the full unsubsidized price to park? 57
Format: F5.2

Q27TIME Q27TIME 58
Format: F1

Value Label

1 Hourly
2 Daily
3 Weekly
4 Monthly

5 Semesterly
6 Other

Q28 Q28 - What time did the trip start? 59
Format: F4

Q28AMPM Q28 AM or PM 60
Format: F1

Value Label

1 am
2 pm

Q29 Q29 - What time did the trip end? 61
Format: F4

Q29AMPM Q29 AM or PM 62
Format: F1

Value Label

1 am
2 pm

Q29AHOUR Q29a - Trip duration hours 63
Format: F2

Q29AMIN Q29a - Trip duration minutes 64
Format: F2

Q30 Q30 - Did you change modes? 65
Format: F1

Value Label

1 Yes
2 No

Q31NAME Q31 - Where did you change modes? 66
Format: A30

Q32 Q32 - To/from what mode did you change? 70
Format: F1

Value Label

1 Bus
2 Car
3 Walk
4 Bicycle
5 Light Rail

HALFMILE Households w/in 1/2 mile of the light rail 71
Format: F1

Value Label

```
0  no
1  yes
```